

## **COGNITIVE ELEMENTS OF EFFECTIVE COLLABORATION**

### **An ONR/SPAWAR Systems Center San Diego Workshop**

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**Towards a cognitive organisational framework for Knowledge Management .**

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*Abstract.*

*This presentation outlines the importance of knowledge management primarily, but not exclusively, in knowledge intensive organisations. A number of cognitive frameworks relating to knowledge management are given, and the need for organisational change to take place in order to facilitate organisational learning is discussed. This presentation proposes to develop in a cognitively linked dynamic framework, a number of disparate concepts, and show their value in co-ordinating knowledge creation. Central to the co-ordination of these disparate concepts is the function of Knowledge Management. Pivotal to the development of knowledge creation in an organisation, are concepts such as organisational learning, product development, problem identification and solution, and facilitating technology. This presentation proposes that these functions are linked by mechanisms of knowledge management, in a manner which is illustrated by the model given in the presentation. The function of knowledge management is therefore, to act as a co-ordinating mechanism.*

*The first section of this presentation describes knowledge management and shows its links with innovation and knowledge creation. The next section outlines the changing forms of organisation needed for knowledge development to occur. The third section draws together a number of the emerging themes in an attempt to suggest a cognitive*

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*framework. The presentation concludes by describing ways of testing the cognitive framework suggested.*

**1. *The importance of Knowledge management in relation to knowledge creation in organisations.***

We can think of the knowledge requirement in organisations as extending across an organisational type continuum as illustrated in Figure 1:

Figure 1: Nature of work and its knowledge requirement

This continuum of knowledge ranges between routine production, where small increments of knowledge are required, through innovation to discovery, where the knowledge requirement is extensive. At the upper extreme of the continuum between routine production, and high level innovation, is the scientist who makes discoveries. The knowledge requirements are so different, that the organisational requirements also become different. The people who will bring such extraordinary innovation about, have been shown to require much greater freedom of thinking and researching, than those in more routine work (Hurley, 1997). To allow such freedom of thought the organisation needs to accommodate them in imaginative ways. In a recent study among science Nobel Laureates Hurley (1997) has shown that eminent scientists value freedom above everything else if their science is to succeed. It is clear that this group of eminent scientists regards freedom as of absolute importance, without which their minds cannot construct a new reality.

***Insert Table 1 here Nobel Laureates Freedom needs***

The freedom the Nobel Laureates speak of is mostly a freedom of the mind, unaffected by social or organisational pressures. It is:

‘Not absolute freedom, and not endless time and boundless resources, but freedom above all to use ones own personality in pursuit of a scientific objective. Freedom to pursue hunches down possibly pointless avenues of exploration; freedom to theorise, experiment, accept, reject, according to the

principal investigators own judgement, with no other interference. And considerable organisational resources are needed to allow this freedom, and give the principal investigator time to reach a satisfactory conclusion.’ Hurley (1997 page 4)

If we are to structure our innovative or discovery oriented organisations in ways which meet the needs of these creative and innovative people, we need also to make important changes in the nature of societal and organisational life to meet these very real needs. The industry of the future is likely to move away from production and towards advanced services such as basic or applied research, software development, product innovation, and discovery. It seems likely that this form of work is going to employ many more people than production enterprises, which will probably move to the Pacific Rim countries. We have seen this happen in many industries before, for example with cotton and other materials, the manufacture of which moving to developing countries, and the technology of this industry and fabric design remaining in the developed world.

In command and control organisations, as in production oriented organisations, the system has to be much more restrictive. These organisations exist on the basis of standardised procedures and practices. Commands must be obeyed without discussion in emergency situations; goods must be produced to a set quality standard. For these organisations, hierarchical structures serve these considerations well, whereas these same structures could be damaging to knowledge creation. Of course this clarity is often somewhat blurred by the existence in such organisations of sub-groups whose function it is to improve systems, or even to develop new ones. These sub-groups however, are usually quite separate from the main command and control or production functions, and may establish their own hierarchies, management systems, and norms.

These brief descriptions of two very distinct kinds of organisation, serve to illustrate the difficulty in considering the application of knowledge management to both. Other distinctions of this kind exist between stages of knowledge processes, for example when science or knowledge is developing, and when it has been developed but needs to move to production processes. The former requires very open free environments, the latter can be more hierarchically controlled.

## 2. *The collaborative imperative in knowledge creation.*

The 'collaborative imperative' of technology, heralded by Hurley (1990) drew attention to the way technological change affecting organisations had introduced collaboration faster than thirty years of legislation had done.

The reasons for this rapid move to collaborative systems, lie fundamentally in the importance of knowledge to modern economies, in particular in the way it adds value to goods and services and makes them more innovative and competitive. Collaborative relationships at work, (as distinct from adversarial ones) make it easier for tacit knowledge to be elicited, and made explicit. According to Polanyi (1958) knowledge about the object or phenomenon that is in focus is *focal knowledge*. Knowledge that is used as a tool to handle or improve what is in focus is *tacit knowledge*. When tacit knowledge is expressed through language, it becomes *explicit knowledge*. Only then can it be focused for reflection and development. It is only when it is explicit that innovation or discovery can be achieved, as creative ideas are often latent and need to be brought to the surface.

In respect to the importance of knowledge within the organisation, the change over the last century is phenomenal. In Frederick Taylor's time, and using the technologies then in use, knowledge was assumed to reside at the top of the organisation, and the actual production took place at the bottom of the hierarchy. Gradually, but at an accelerated pace in the last five years, service organisations such as those in finance, advisory work, and software development and internet activity, have found that this hierarchical arrangement has had to be almost reversed. Many of the key areas of knowledge now exist only at the *bottom* of the organisation, with management uninformed on specific detail. For many knowledge-based organisations this has led to de-layering taking place within organisations at a rate and scale never seen before. The 'Flight from hierarchy' has been rapid because to such organisations the processes of eliciting tacit knowledge and making it explicit are their most important source of knowledge creation.

More importance is attached to decentralised, flat organisations, where people collaborate around problems. The reason for this departure from earlier certainty, lies in the fundamentally personal and social nature of knowledge. According to Ravetz

(1971) 'Scientific knowledge is achieved by a complex social endeavour, and derives from the work of many craftsmen in their very special interaction with the world of nature' (p.81).

Tovstiga (1999) makes a related point :

*"..... increasingly, organisations also understand that their knowledge processes are inextricably linked to the organisation's internal context - its internal management practices, learning culture and knowledge base. This has particularly been found to be the case with the tacit form of knowledge - that highly intangible and essential part of 'knowing how' and 'knowing why' on which technological innovation is primarily dependent." Tovstiga (1999)*

Figure 1

We need to know the nature of the process by which this innovation is introduced, and its cognitive linkages and reference points. An attempt will be made here to delineate these processes and linkages. It must be regarded as tentative and exploratory, and by no means as certain as the description of it might suggest.

The organisational processes and stages related to innovation and knowledge creation, can be conceived as a continuous process along the following lines:

***Insert Figure 3 here***

### ***3. A possible cognitive framework.***

Nonaka and Takeuchi (1995) have the view that the West has ignored the rich resources among the personnel in their own organisations. Their view of the process is based in 'Kaizen'. Within the Western culture we may well have ignored important insights in our own tradition. Traditionally, in the West we have approached the innovation process from several psychological and scientific aspects. The scientific approach is based on empirical testability and although flawed and subject to revision, it is the only objective mode of pursuing knowledge. The scientific method aims to produce knowledge of the world by the establishment of generalisations governing the behaviour of the world (Chalmers, 1990). Taylorism was based on this.

Polanyi (1958) at a philosophical level and Nonaka and Takeuchi (1995) in a more applied way, have both drawn attention to the central importance of eliciting 'tacit' knowledge. Neither gives entirely satisfactory descriptions as to how this is done, nor what the psychological or group mechanisms underlying the process are. Nonaka and Takeuchi refer to the group socialization process, and criticise western organisations for being excessively influenced by rational models such as Taylorism. They suggest that there is a wealth of tacit knowledge that lies largely unknown in many organisations.

Knowledge management appears to be a facilitating and brokering process to put in place to ensure the effectiveness of the knowledge development system. Thomson and Warhurst (1998) emphasise this brokering aspect.

***Figure 4 here***

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If we see knowledge management as essentially the management of these relationships then a cognitive/organisational theory could be seen in the following way:

***Insert Figure 5 here***

This representation seems reasonable as a representation of the knowledge management process, it needs to be verified in an empirical way, if it is to be tested properly. The absence of such empirical testing in the area of knowledge management is perhaps partly because of the relative novelty of the field and partly because of the difficulty in quantifying its key concepts. To a great extent the importance of the above components to knowledge development are supported by the available literature. A brief summary of the immediately related literature is given here which leads into the programme for scientific testing which is the last section.

***1: Learning Culture.***

Senge (1990) defined a learning organisation as 'an organisation that is continually expanding its capacity to create its future' (p. 14). Senge's five disciplines have much in common with Nonaka and Takeuchi (1995) approach. Both emphasise sharing and knowledge elicitation. Finerty (1997) in one study found that the establishment of a learning culture supported by powerful knowledge systems can transform the rate and quality of learning. Those factors

found to be key to the learning culture not only helped accelerate the rate of learning and knowledge creation, but also provided a solid foundation for building meaning and motivation in the workplace. Their case study describes how Action Learning, supported by an intranet knowledge system (Open Learning Centre), provided the means to capture and leverage knowledge as well as contributing to skills development.

In one study, Arad, Hanson and Schneider (1997) developed using factor analysis, a taxonomy of organisational characteristics and showed that a series of these factors form a strong relationship with innovation.

## *2: Requisite information and knowledge.*

In addition to a learning culture, a resident information and knowledge system would need to be put in place which would ensure that the current knowledge would not be lost, for example if a colleague left the organisation. This could be modelled on an elaborate Management Information System, but designed around the ready availability of knowledge to each person.

## *3: Requisite technical systems.*

"Nothing tends so much to the advancement of knowledge as the application of a new instrument. The native intellectual powers of men in different times are not so much the causes of the different success of their labours, as the peculiar nature of the means and artificial resources in their possession". Davy, Sir Humphrey in Hager (1995)

This point has been illustrated by our experience of the development of R&D throughout the years. An instrument, for example the electron microscope, or more recently the scanning tunnelling microscope, open up the possibility of testing imaginative theories, which had hitherto been merely speculation. The existence in an organisation of the requisite technical systems to support the knowledge development process is essential. Depending on the nature of the technology in which innovation is being pursued, the technology required may need to be well in advance of existing state of the art technology, so that the technical base is sufficient to allow new developments. The development of instrumentation has always been essential for innovation. The development of



the electron microscope made one series of advances possible; the development of scanning tunnelling microscopy another series.

X-ray crystallography made peptide sequencing and human genome analysis possible. Hence for any innovation, highly advanced technology is required to support it.

#### *4: Existence of an equitable reward system.*

Organisational approaches to reward have tended to be divided into two situational areas. Where the individual's work does not greatly affect output as in mass production, then the rewards are fixed. When the individual's work affects output directly, then rewards are variable and linked to performance. This latter situation is illustrated by sales activity and by software development as examples. Reward systems have in some cases, been used to shape behaviour, and it seems reasonable to expect that those involved with the growth of knowledge, should be rewarded if their work contributes to measurable improvements in effectiveness or competitiveness.

It is perhaps no accident then that the most widely used method of reward in the knowledge development area is in fact the granting of shares or share options in the organisation. Another widely used method is the system of rewarding suggestions known as '**Vorschlagswesen**' used in Germany for about fifty years with considerable success (Nickel et al 1998). They found that "The dimensions of friendliness, activation, and co-operation were correlated with the suggestion rate". This supports Nonaka and Takeuchi's view that tacit knowledge is elicited best by socialisation among colleagues.

Nevertheless, this study also shows that a suggestion reward system encourages suggestions.

#### *5: Ability to identify problems.*

Austin (1997) distinguishes between active processing and automatic processing in solving differing types of problem. He states that:

"In an active processing mode, an individual uses greater contextual awareness to assess the immediate situation. Whereas automatic processing leads to behavior without attention, active processing leads to an acute awareness of

the situation. Active processing allows the individual to formulate a new schema by actively taking in new contextual information. The contextual information combines with several different existing schemas or parts of existing schemas in a way that allows the individual to understand the situation. The individual tests the new schema before integrating it into the existing knowledge structure."

The greater emphasis in the literature has been on active learning processes, and these processes are indeed those used in the development of new knowledge (Argyris & Schon, 1978). Brugman (1995) has pointed out that problem finding is a neglected area of the research literature, though the importance of this area is growing at present. He suggests a useful strategy for the expansion of competencies in this area. As long ago as 1917, Dewey, (1917, 1933) explored this topic. There followed a long period of greater interest in problem-solving, which has led to many useful results. Getzels and Csikzentmihalyi, 1976; Perkins, 1981; Sternberg, 1984; Gardner, 1984; Runco (1994).

Perkins idea of the problem space where explorers go into new lands the terrain uncharted, the outcomes unknown, is a very imaginative and stimulating one. (See "smart foraging" below)

#### *6: Ability to solve these problems.*

Within any group, dynamics of different kinds emerge. Anderson and West (1998) Many groups approach the solution of problems in any entirely rational way. They very often find however, that after a while, progress slows down, and the problem seems to become insoluble. In this case group problem solving strategies which combine rational approaches with intuitive ones, can be useful, even essential.

#### **Collaborative processes:**

##### *7. Knowledge sharing*

Nonaka and Takeuchi (1995) describe the way in which new knowledge is created as:

*Sharing of tacit knowledge* – correlates closely to the socialization process of knowledge conversion;

*Creating concepts* - involves the conversion of the shared tacit knowledge into explicit knowledge

*Justifying concepts* - is an internal verification mechanism,

*Building an archetype* - is a form of rapid prototyping, this can either be a 'hard' Product development or a 'soft' organisational entity; various forms of explicit knowledge are combined in this phase;

*Cross-levelling knowledge* – ensures a wide exchange of knowledge both within the organisation and in exchange with its external environment

In the new organisation knowledge is shared -not hoarded to increase an individuals power. It is shared in order to create something new. The newly developing concept or product has to be justified and shown to work. Rapid prototypes are created and knowledge is spread throughout the whole organisation.

#### *8. Double-loop learning*

Organisational learning can also be seen as an application of Argyris and Schon (1978) single loop (adaptive) and double-loop (generative) forms of learning. Group practices that strive toward double-loop learning in order to find the right problems, and better generate new ideas and solutions, can add to the experience of a supportive organisation.

#### *9. Active idea generation*

It is a characteristic of much developmental research that it explores a topic in great depth. This deep exploration sometimes has the unintended consequence of making the topic sterile, and the project runs out of creative ideas.

This is a well known psychological phenomenon, which has been recognised in by the development of a number of group problem solving techniques, which use both the rational and intuitive approaches to problems. Included in this group is the technique of brainstorming. Brainstorming is a technique of creative problem solving which separates the process of idea generation, from the process of evaluation. Evaluation of ideas is known to diminish the flow of ideas. The idea in brainstorming is to get the quantity of ideas first, because among this larger quantity, some useful germs of good ideas may exist. The evaluation of these ideas is then carried out, and the development of the ideas is a further phase.

This technique of creative problem solving has been developed further in the system known as 'Synectics' In 'Synectics' a number of additional techniques for the encouragement of new ideas are used. The brainstorming techniques are used to begin with, and then in a separate session, the ideas are not evaluated but put in the form of possible uses. Each idea is regarded initially as having some possible merit. Then the disadvantages of each idea are turned into positives by imagining how the disadvantages could be overcome. I have seen this technique used in the development of research ideas very successfully, when the research group found itself running out of useful ideas for further progress. According to Prince (1980) who developed

'Synectics', the six cognitive processes which take place in idea generation are: wishing, retrieving, imaging, comparing, transformation and storing. In 'wishing' we are motivated to have a new idea. Working in a group can help with this by the rivalry for attention that exists in a group, which does not exist on ones' own. In 'retrieving' we retrieve information from the memory which might be useful in the generation of this new idea, or in the solution of this particular problem. In 'imaging' we develop mind pictures of possible solutions, we compare these ideas with existing ones, we transform them where necessary, and we store the idea.

According to Prince, this process of idea generation is greatly interfered with by other learned cognitive processes. These processes include our general habit of having criteria to evaluate our own performance, and this tends to diminish our creative capacity. Our habits of social thinking, developed in order to help us get on with others, also interfere with our uniquely individual approach to ideas. The associated group dynamics involved in techniques of idea generation can develop the ability to draw analogies, and bring them in from a wide variety of sources. Given that the scientists mind is already full with the problem being addressed, these techniques can be very useful in reaching novel and imaginative solutions and re-formulations.

#### 10. *Smart Foraging*

Perkins model which he calls "smart foraging" fits the process of innovation and discovery very well. The researcher is "well tuned to the topography of ideas" in his chosen general area of research. Perkins (1981). This model builds on Newell and Simon's (1972) model, which suggest the notion of the 'problem space' as the cognitive area within which the problem is identified. This 'problem space' is the area of the world of knowledge which the scientist or developer is familiar with, which may include a number of disparate areas of research, and which contains problems which are known to him or her. The aim is to arrive at a new target state which will provide an advance on the existing state of knowledge or insight in the defined 'problem space'. With problems that lack a clear specifiable path toward a solution, individuals often have to go beyond and outside the problem space in order to reach towards solutions. As this involves new insight, this idea of problem spaces, seems to connect very well with the idea that substantial innovators need freedom to reach new insights in solving problems.

#### 11. *Group Think*

Janis (1971) describes 'group think' as the mode of thinking that persons engage in when concurrence seeking becomes so dominant in a cohesive in-group, that it tends to override realistic appraisal of alternative causes of action' Janis and Mann(1977)

symptoms of group think include:

1. The group shares an illusion of invulnerability
2. the group engages in collective rationalisation to discount dissonant information
3. The group believes in inherent morality of what it has to do
4. The group develops stereotypes of other groups and of dissenters which protects it from accurate analysis
5. The group puts direct pressure on dissenters in order to silence them
6. The group censors its own thoughts and doubts
7. The group believes in unanimity due to lack of dissent " silence = consent'
8. some members of the group come to function in the role of mind guards watchmen who protect the leaders from dissenting views by discouraging these views.

If a leader or manager is to prevent these circumstances, must set up conditions that encourage dissent, critical judgement and checking of assumptions.

If not prepared to hear group dissent don't use group process.

Group think, leads to group polarisation, where the group tends to solve a problem or make a decision in one direction ignoring other alternatives. Group think is an extreme form of group polarisation, which is a tendency for groups following group discussion, to arrive at a more extreme (or polarised) decision on some issue than the average of decisions made by the same group of people when making an individual decision (Manstead and Semin, 1988).

The major dimensions of knowledge development have been outlined in the foregoing text. Of these dimensions, some are cognitive, some collaborative, and some organisational. And inevitably, there is overlap, for this is a field where definitions are few, and borders and interpretations many. Tacit knowledge may be seen as an implicit dimension in cognitive framework presented here. The wayby which that tacit knowledge is made explicit and turned into shared and possibly useful new knowledge is the key function of knowledge management.

The following table attempts to summarize the complex of relationships involved:

TABLE 4: Organisational and collaborative linkages with cognitive aspects of knowledge development

<b>COGNITIVE FUNCTIONS</b>	<b>ORGANISATIONAL</b>	<b>COLLABORATIVE DIMENSIONS</b>
	LEARNING CULTURE	PROBLEM FINDING -SMART FORAGING
	REQUISITE INFORMATION	PROBLEM SOLVING -ACTIVE IDEA GENERATION
	REQUISITE TECHNOLOGY	KNOWLEDGE SHARING -DOUBLE LOOP LEARNING
	REWARD SYSTEM	
	AVOIDING GROUPTHINK	

#### ***4. Testing the theory: measuring the variables, testing the hypotheses.***

To begin with the outcome measure; we need to quantify what is meant by knowledge development. We are dealing with a difficult field here where almost no variable is directly definable, measurable or quantifiable. Unlike salary costs, expenses, absenteeism and many other variable, the variables involved are only assessable as perceptions of reality, and therefore valid and reliable measures will have to be developed to assess them.

Does any piece of new knowledge -however trivial- constitute the development of knowledge? Perhaps not, but this illustrates the difficulty and it needs to be overcome. In the absence of a truly objective measure innovative achievement, we might for example develop a scale of knowledge development which might look like this:

***Insert Table 5 here***

A number of independent expert assessors would rate the outcome of a knowledge development activity and an agreed figure would be allocated to each result.

In a similar way we need to be able to measure every other aspect of the theory we propose. The extent of the learning culture; the extent of the existence of the requisite knowledge; the extent of the existence of requisite technical support; the extent of the ability identify the right problems; the extent of the ability to solve those problems; and the extent of an equitable reward system.

If we are to verify our cognitive model of the knowledge management process we must then guide the process with a series of hypotheses based on the related literature. These hypotheses might be framed as follows:

*Table 2 here: Hypotheses*

*Table 3 Hypotheses*

When we have made measurable the processes involved in knowledge development, and seen it as the successful outcome of a good knowledge management system, we can test our hypotheses. When this is done, and only then, will we know if our current conception of knowledge management is really useful, or another fashion to be written off as part of the human learning process.

What is outlined here is a possible explanatory theory, and as Kurt Lewin pointed out "There is nothing as useful as a good theory". A testing procedure is also given which could form the basis of a programme for assessing the theory.

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